OPTIMIZED ADJACENT CHANNEL SEARCH AND TIMESLOT ASSIGNMENT FOR

MULTIPLE TIMESLOT MOBILE STATIONS

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Cross-Reference to Related Application:

This is a continuation of copending International Application PCT/DE98/02452, filed August 21, 1998, which designated the United States.

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Background of the Invention:

Field of the Invention:

The invention lies in the field of communications. The invention relates to a method for transmitting data packets between at least one base station and at least one mobile

15 station in a mobile radio system, and to a system for transmitting data packets between at least one base station and at least one mobile station in a mobile radio system.

20 Methods and systems for transmitting data packets between at least one base station and at least one mobile station in a mobile radio system exist. During a call, that is to say when connected, a mobile station in a mobile radio system regularly has to search predetermined frequencies for data packets from

25 adjacent base stations, and to recognize the identity of the base stations, while the mobile station is connected to a

present or current base station. Decoding the base station

identity code (BSIC) in the synchronization data packet

generally carries out the identity recognition. To perform

decoding, each base station regularly transmits

5   synchronization data packets. In the GSM Standard, the base

stations transmit a synchronization data packet every 10 or 11

time frames, lasting for one timeslot, and with eight

timeslots forming a frame.

10   In the GSM Standard, when a mobile station is making a call,

it can monitor an adjacent channel every 26 frames, for a

period of somewhat more than one time frame. The one

predetermined time frame is called the idle frame, in which

the mobile station does not interchange any data with the

15   present base station. The predetermined time frame is used to

monitor adjacent channels and, possibly, to find and to decode

synchronization data packets from adjacent base stations. In

the GSM Standard, the base stations transmit five

synchronization data packets, with a duration of one timeslot,

20   within one multiframe, including 51 time frames. The

synchronization data packets are transmitted by the base

stations four times every 10 frames and then once after 11

frames. Because the mobile station has a predetermined time

frame for monitoring the adjacent channels available every 26

25   time frames, a mobile station can receive a synchronization

data packet from an adjacent base station after at most 11

blank time frames, regardless of the relative timing of the synchronization data packets of the base stations.

Standard mobile stations in the GSM system use only one of
5   eight possible timeslots per time frame for interchanging data with a respective base station. In order achieve higher data rates, multiple timeslot mobile stations have been defined (the GSM term is HSDSC) which, in the extreme, can receive and/or transmit data in up to all eight timeslots. The
10   invention relates in particular to such multiple timeslot mobile stations.

As mentioned above, a standard mobile station can monitor an adjacent channel, while making a call, every 26 frames for a
15   period of somewhat more than one time frame, in other words, for approximately nine timeslots. Monitoring is necessary because the respective base station and the mobile station are not yet synchronized, and the respective timeslots may be shifted with respect to one another. In multiple timeslot
20   mobile stations, a problem that arises is that the time frames before and after the predetermined time frame may be occupied by the transmission of data packets, and that the predetermined time frame with eight timeslots is too short to allow a synchronization data packet from an adjacent base
25   station to be received and studied reliably. Therefore, there is a critical relative phase area in which the synchronization

data packet (SC burst) is located in such an unfavorable

manner that it cannot be received and decoded. Such a

condition is precisely what happens if the synchronization

data packet overlaps the boundary of the predetermined time

5   frame. The situation is shown in Fig. 12.

In Fig. 12, solid lines are used to show the time frames with

timeslots 0, 1...7 in which a mobile station receives data

packets from a present base station. The predetermined time

10   frames that are available for reception of synchronization

data packets and/or for measurement of signal levels of

adjacent base stations as well are identified by dashed lines.

In Fig. 12, the upper line shows the timing sequence for the

time around a predetermined time frame, during which the base

15   station does not transmit any data packets, and the lower line

shows the timing sequence at a later time, with subsequent

predetermined time frame, during which the base station is

transmitting SACCH data packets. The time axes have been

chosen so that the timing of the synchronization data packet

20   (SC burst) from the adjacent base station is the same. S0 to

S7 are the timeslot numbers of the SACCH channel, while 0 to 7

are the timeslot numbers for the wanted data channels. The

two small boxes with bold boundaries represent the two

critical locations of the synchronization data packet from the

25   adjacent base station, which are each located directly at the

boundary of the predetermined time frame. If the mobile

station switches to reception of synchronization data packets from the adjacent base station only during the eight time frames that are available during the predetermined time frame, then the synchronization data packets that arrive from the

5   adjacent base station in one of the indicated locations cannot be completely received, and, thus, cannot be decoded and used.

In order to overcome the problem, a second receiver is provided in conventional multiple timeslot mobile stations,

10   and is used specifically for reception of synchronization data packets and/or for measurement of signal levels from adjacent base stations. Thus, the second receiver is operated in parallel with the first receiver and is used during the entire time interval that is required for monitoring and/or reception

15   of synchronization data packets from adjacent base stations. However, the use of a second receiver is costly and wastes energy.

Summary of the Invention:

20   It is accordingly an object of the invention to provide an optimized adjacent channel search and timeslot assignment method and system for multiple timeslot mobile stations that overcomes the hereinafore-mentioned disadvantages of the heretofore-known methods and devices of this general type and

25   that eliminates the need for using a second receiver in the mobile stations.

With the foregoing and other objects in view, there is

provided, in accordance with the invention, in a method for

transmission of data packets between at least one base station

5   and at least one mobile station in a mobile radio system, the

improvement including transmitting each of the data packets in

time frames having a fixed number of timeslots, transmitting

data packets from a mobile station in a plurality of

successive timeslots, transmitting at least one of control

10   data packets and no data packets from a given base station to

the mobile station during predetermined time frames while the

mobile station is connected to the given base station, and

respectively making available to the mobile station a time

interval longer than a predetermined time frame for at least

15   one of receiving synchronization data packets and measuring

signal levels of adjacent base stations.

In the method for transmission of data packets, the time

interval, which is longer than a predetermined time frame, is

20   respectively made available to the mobile station in order to

receive synchronization data packets and/or signal levels of

adjacent base stations. Therefore, the invention

advantageously avoids the use of a second receiver in the base

station, thus allowing the costs and the energy consumption in

25   the base station to be reduced considerably.

In accordance with another mode of the invention, during the time interval, the mobile station switches to reception of at least one of synchronization data packets and measurement of signal levels of adjacent base stations.

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Advantageously, the mobile station is switched, during the time interval, to reception of synchronization data packets and/or to measurement of signal levels of adjacent base stations. It is also advantageous for the mobile station at

10   least partially not to receive the data packet transmitted by the transmitting unit of the present base station in each case immediately before and/or after a predetermined time frame.

In accordance with a further mode of the invention, the given

15   base station transmits the data packet at least one of immediately before and immediately after a predetermined time frame is at least partially not received by the mobile station.

20   In accordance with an added mode of the invention, the mobile station reconstructs data packets at least partially not received using redundant coding of other received data packets.

25   Furthermore, those data packets at least partially not received are reconstructed by the mobile station, in an

advantageous manner, by the redundant coding and the other

received data packets.

In accordance with an additional mode of the invention, the

5   data packet transmitted by the given base station is

transmitted once again at least one of immediately before or

immediately after the predetermined time frame on at least one

of the end and the start of the predetermined time frame.

10   In this case, the data packet transmitted by the present base

station immediately before or after the predetermined time

frame is advantageously transmitted once again at the end or

at the start of the predetermined time frame. Alternatively,

the data packet transmitted by the present base station

15   immediately before or after the predetermined time frame can

be transmitted once again during the predetermined time frame

and, respectively, can be received by the mobile station.

In accordance with yet another mode of the invention, the data

20   packet transmitted by the given base station is transmitted

once again at least one of immediately before or immediately

after the predetermined time frame during the predetermined

time frame, and the mobile station receives the data packet.

25   In accordance with yet a further mode of the invention, a

length of the time interval during which the mobile station is

switched to reception of synchronization data packets from adjacent base stations is chosen such that the mobile station can receive a first part of a synchronization data packet in a first time interval, and can receive a second part of a

5   synchronization data packet in a second time interval.

The length of the time interval during which the mobile station is switched to reception of synchronization data packets from adjacent base stations is advantageously chosen

10   such that the mobile station can receive a first part of a synchronization data packet in a first time interval, and can receive a second part of a synchronization data packet in a second time interval. The first part and the second part may each contain at least one section of the training sequence of

15   the synchronization data packet that allows a respective channel equalization to be determined.

In accordance with yet an added mode of the invention, having the first part of the synchronization data packet and the

20   second part of the synchronization data packet each contain at least one section of a training sequence of the synchronization data packet to allow a channel equalization to be determined.

25   In accordance with yet an additional mode of the invention, a first mobile station transmits data packets and is switched to

receiving data packets at different times, a second mobile station is switched to reception of data packets in timeslots during which the first mobile station is transmitting data packets, and data packets are transmitted in timeslots during

5   which the first mobile station is switched to reception of data packets.

Advantageously, a first mobile station transmits data packets and is switched to reception of data packets at different

10 times, with a second mobile station being switched to reception of data packets in timeslots in which the first mobile station is transmitting data packets, and transmitting data packets in timeslots in which the first mobile station is switched to reception of data packets.

15

With the objects of the invention in view, there is also provided a system for transmission of data packets in a mobile radio system, including at least one base station having a transmitting unit, and at least one mobile station having a

20 receiving unit, the at least one base station and the at least one mobile station transmitting data packets in time frames having a fixed number of timeslots, the at least one mobile station transmitting data packets in a plurality of successive timeslots, in which, while the at least one mobile station is

25 connected to a given one of the at least one base station, the transmitting unit of the given base station transmits at least

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one of control data packets and no data packets to the at

least one mobile station during a predetermined time frame, a

respective one of said receiving units of the at least one

mobile station has available a time interval longer than the

5   predetermined time frame for at least one of receiving

synchronization data packets and measuring signal levels of

adjacent base stations.

In the system for transmission of data packets, a time

10   interval, which is longer than a predetermined time frame, is

respectively made available to a receiving unit of the mobile

station in order to receive synchronization data packets

and/or to measure signal levels of adjacent base stations.

Therefore, the invention advantageously avoids the use of a

15   second receiver in the base station, thus allowing the costs

and the energy consumption in the base station to be reduced

considerably.

In accordance with again another feature of the invention, the

20   receiving unit of the at least one mobile station switches to

at least one of reception of synchronization data packets and

measurement of signal levels of adjacent base stations during

the predetermined time interval.

25   In accordance with again a further feature of the invention,

the receiving unit of the at least one mobile station at least

partially does not receive a data packet transmitted by the transmitting unit of the given base station at least one of immediately before and immediately after the predetermined time frame.

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In accordance with again an added feature of the invention, the at least one mobile station has a processing unit reconstructing data packets at least partially not received using redundant coding of other received data packets.

10

In accordance with again an additional feature of the invention, the transmitting unit of the given base station transmits once again a data packet transmitted at least one of immediately before and immediately after the predetermined

15   time frame on at least one of the end and the start of the predetermined time frame.

In accordance with still another feature of the invention, the transmitting unit of the given base station transmits once

20   again the data packet transmitted at least one of immediately before and immediately after the predetermined time frame during the predetermined time frame, and the receiving unit of the at least one mobile station receives the data packet.

25   In accordance with still a further feature of the invention, a length of the time interval during which the receiving unit of

the at least one mobile station switches to reception of synchronization data packets from adjacent base stations is chosen such that the receiving unit of the at least one mobile station can receive a first part of a synchronization data

5 packet in a first time interval, and can receive a second part of a synchronization data packet in a second time interval.

In accordance with still an added feature of the invention, the first part and the second part of the synchronization data

10 packet each contain at least one section of a training sequence of the synchronization data packet allowing a respective channel equalization to be determined.

In accordance with a concomitant feature of the invention, the

15 at least one mobile station is two mobile stations including a first mobile station transmitting data packets and switched to receiving data packets at different times, and a second mobile station switched to receiving data packets in timeslots during which the first mobile station transmits data packets and

20 transmits data packets in timeslots during which the first mobile station is switched to reception of data packets.

Other features that are considered as characteristic for the invention are set forth in the appended claims.

25

Although the invention is illustrated and described herein as embodied in an optimized adjacent channel search and timeslot assignment for multiple timeslot mobile stations, it is nevertheless not intended to be limited to the details shown

5   because various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

10 The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

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Brief Description of the Drawings:

Fig. 1 is a functional block diagram of a mobile radio system with a base station, an adjacent base station, and a mobile station according to the invention;

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Fig. 2 is a diagrammatic illustration of a first exemplary embodiment of data packet transmission according to the invention;

25 Fig. 3 is a diagrammatic illustration of a second exemplary embodiment Fig. 2;

Fig. 4 a diagrammatic illustration of a third exemplary

embodiment Fig. 2;

5   Fig. 5 a diagrammatic illustration of a fourth exemplary

embodiment Fig. 2;

Fig. 6 a diagrammatic illustration of a fifth exemplary

embodiment Fig. 2;

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Fig. 7 a diagrammatic illustration of a sixth exemplary

embodiment Fig. 2;

Fig. 8 a diagrammatic illustration of a seventh exemplary

15   embodiment Fig. 2;

Fig. 9 a diagrammatic illustration of critical overlapping

areas in prior art multiple timeslot mobile stations;

20   Fig. 10 a diagrammatic illustration of a eighth exemplary

embodiment Fig. 2;

Fig. 11 a diagrammatic illustration of a ninth exemplary

embodiment Fig. 2; and

25

Fig. 12 is a diagrammatic illustration of a critical position

of synchronization data packets in a prior art mobile radio

system.

5   Description of the Preferred Embodiments:

In all the figures of the drawing, sub-features and integral

parts that correspond to one another bear the same reference

symbol in each case.

10 Referring now to the figures of the drawings in detail and

first, particularly to Fig. 1 thereof, there is shown the

basic configuration of a mobile radio system with a base

station 1 including a receiving unit 2, a transmitting unit 3

and a conventional antenna 4. Also shown is a mobile station

15 5 having a receiving unit 6, a transmitting unit 7, and a

conventional antenna 8. An adjacent base station 9 is

likewise provided and includes a receiving unit 10, a

transmitting unit 11, and a conventional antenna 12. The

mobile station 5 is connected to the present base station 1 to

20 make a call and, during predetermined time frames (during

which the present base station 1 does not transmit any data

packets or control data packets, such as SACCH data, to the

mobile station 5) switches to reception of synchronization

data packets and/or to measurement of signal levels from the

25 adjacent base station 9. According to the invention, the

receiving unit 6 of the mobile station 5 switches to reception

of synchronization data packets and/or to measurement of
signal levels, inter alia, from the adjacent base station 9
during a time interval, or a portion of a time interval, which
is longer than a predetermined time frame.

5

A common feature of the exemplary embodiments of the invention
shown in Figs. 2 to 7 is that the transmitting unit 3 of the
base station 1 once again transmits a data packet, which has
been sent to the mobile station 5 and is located immediately

10   before or after the predetermined time frame. In the
exemplary embodiments in Figs. 2 to 5 and 7, the data packet
that has been transmitted once again is transmitted once again
at the end or at the start of the predetermined time frame
while, in the exemplary embodiment in Fig. 6, the transmitting

15   unit 3 of the present base station 1 once again transmits the
data packet, which has been transmitted once again, during the
predetermined time frame, and the receiving unit 6 of the
mobile station 5 receives the data packet during the
predetermined time frame as well.

20

The illustration of the exemplary embodiments in Figs. 2 to 7
corresponds to the illustration in Fig. 12. The topmost line
in each case shows the data packets transmitted by the present
base station 1 in the timeslots 0 to 7 by solid lines, while a

25   predetermined time frame during which the base station 1 does
not transmit any data packets is shown by the dashed lines.

The search by the mobile station 5 for synchronization data

packets and the measurement of signal levels from the adjacent

base station 9 each take place in the timeslots 0 to 7, which

are shown in the second line and are represented by solid

5   lines.   The small boxes with bold boundaries, which identify

the critical positions of the synchronization data packets (SC

bursts) transmitted by the adjacent base station 9 (see Fig.

12) are not shown in Figs. 2 to 7 and 9 to 11.   In a standard

mobile station, the measurement of the signal levels and of

10   the adjacent field strengths is carried out in a timeslot that

is not used for transmission or reception, and with a multiple

timeslot mobile station the measurement can likewise be done

in the predetermined time frame.   The option is shown in the

figures of the drawing by the small boxes denoted NB, which

15   identify timeslots in which the mobile station 5 measures the

field strength of the channels and/or the signal levels of

adjacent base stations.

Furthermore, in the exemplary embodiments of Figs. 2 and 3, it

20   is possible for the mobile station 5 not to receive any SACCH

data packets, or not to receive all of them, from the base

station in specific timeslots of the SACCH time frame.   In the

present version of the GSM Recommendations, a mobile station

has to receive SACCH data packets in all the timeslots of an

25   SACCH time frame and (at least) must also use the information

in the timeslots in which it is transmitting.   Thus, the power

of the mobile stations in the uplink is regulated. However, it is also possible to dispense with reception of certain timeslots, in which case the mobile station must then use the same power as for the other timeslots. The foregoing

5 principle is already used in a downlink in a situation where a mobile station transmits in fewer timeslots than in those that it receives. The lower lines of the illustrations in Figs. 2 and 3 each show such a situation, in which the reception of SACCH data packets in four timeslots of the SACCH time frame

10 (S0, S1, . . . , S7) has been dispensed with.

Fig. 2 shows the first exemplary embodiment of the invention, in which the base station 1 once again transmits the data packet from the timeslot 7 immediately before the

15 predetermined time frame at the end of the blank time frame. The redundantly repeated data packet is identified by the small box 7R. The redundant transmission of the last data packet before the predetermined data packet at the end of the predetermined data packet is also carried out in the second to

20 fifth exemplary embodiments in Figs. 3 to 6.

In the sixth exemplary embodiment shown in Fig. 7, the data packet from the timeslot 0 is transmitted immediately after the predetermined data packet and, actually, at the start of

25 the predetermined data packet, as is identified by the small box 0R.

Therefore, a common feature of all the exemplary embodiments

shown in Figs. 2 to 7 is that the data packets that are

transmitted in a timeslot at the boundary of the predetermined

5   time frame are transmitted by the base station 1 twice, and

the mobile station 5 can then optionally also receive the

information at the alternative time, thus gaining additional

time to carry out the search for synchronization data packets

and/or for measurement of signal levels from the adjacent base

10   station 9.   The additionally obtained time is just sufficient

to allow the synchronization of the adjacent base stations to

be carried out in all the cases that occur.

As the lower line in Fig. 2 shows, the receiving unit 6 of the

15   mobile station 5 is switched to reception and measurement of

signal levels from adjacent base stations during the first two

timeslots S0, S1 of the SACCH time frame.   In the last two

timeslots 6 and 7 of the SACCH time frame, the receiving unit

6 of the mobile station 5 is switched to reception of

20   synchronization data packets from adjacent base stations.

In the exemplary embodiment shown in Fig. 3, the receiving

unit 6 of the mobile station 5 is switched to reception and to

measurement of adjacent signal levels in the last timeslot

25   (i.e., timeslot 6) of the time frame 7,0...6 that is used for

reception of synchronization data packets from the adjacent

base station 9.   In the SACCH time frame, the first timeslot

S0 is used to measure adjacent levels, while the last three

timeslots S5, S6 and S7 are used to search for synchronization

data packets.   The timeslots S1, S2, S3, S4 of the SACCH frame

5   are received, as intended, by the base station 1.

In the exemplary embodiment shown in Fig. 4, the receiving

unit 6 of the mobile station 5 is switched to reception of

synchronization data packets from the adjacent base station 9

10   during all the timeslots 7,0...6.   In the next predetermined

time frame, which is shown in the lower line in Fig. 4, the

first six timeslots 0,1...5 are then used for measurement of

the signal levels from adjacent base stations, while the last

two timeslots 6, 7 are used to search for synchronization data

15   packets.

In the exemplary embodiment shown in Fig. 5, the last three

timeslots of the predetermined time frame are used for

measurement of signal levels from adjacent base stations,

20   while the first five timeslots 7,0,...3 are used to search for

synchronization data packets.   In the predetermined time frame

following the search, which is shown in the lower line of Fig.

5, the first three timeslots 0, 1, 2 are then used for

measurement of signal levels from adjacent base stations,

25   while the last five timeslots 3,4,..., 7 are used to search

for synchronization data packets.

In the exemplary embodiment shown in Fig. 6, the first five timeslots 7,0,..., 3 of the predetermined time frame are used to search for synchronization data packets from adjacent base

5   stations, while the base station 1 transmits the data packet 7R once again in the fifth timeslot 4, this being the data packet that it had already transmitted immediately before the blank time frame. In the next three timeslots, the mobile station 5 measures signal levels from adjacent base stations.

10   In the next predetermined time frame, which is shown in the lower line of Fig. 6, the signal levels from adjacent base stations are measured in the first three timeslots of the blank time frame, while a search for synchronization data packets is carried out in the following five timeslots

15   3,4,..., 7.

In the exemplary embodiment shown in Fig. 7, the base station 1 transmits the data packet in the timeslot 0 immediately after the end of the predetermined time frame, right at the

20   start of the predetermined time frame, as is shown by the small box 0R. In the first three timeslots of the blank time frame, the mobile station 5 measures signal levels from adjacent base stations, while the mobile station 5 searches for synchronization data packets in the last five timeslots

25   4,5,...0. In the next predetermined time frame, which is shown in the lower line of Fig. 7, the mobile station 5

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searches during the first five timeslots 0,1...4 of the

predetermined time frame for synchronization data packets from

adjacent base stations, while it carries out a measurement of

the signal levels from adjacent base stations in the last

5   three timeslots.

A common feature of all of the exemplary embodiments of Figs.

2 to 7 is that the mobile station 5 at least partially fails

to receive the respective data packet transmitted immediately

10   before and/or after the predetermined time frame because the

single receiving unit 6 of the mobile station 5 switches to

reception of synchronization data packets and/or measurement

of signal levels from adjacent base stations during a time

period that is longer than a predetermined time frame.

15

If the transmitting unit 3 of the base station 1 does not

carry out any repetition of data packets whatsoever, the

receiving unit 6 of the mobile station 5 can also suppress

reception of the last timeslot before the predetermined time

20   frame, or the first timeslot after the predetermined time

frame. Specifically, because the data to be transmitted are

coded redundantly in the base station 1, the data received by

the mobile station 5 can be completely decoded if the field

strengths and/or reception conditions are correspondingly

25   good. However, if the reception conditions are not optimal,

increased error rates can be expected. If the data packets in

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the two timeslots at the boundary of the predetermined time
frame were both partially not received, a better distribution
of any existing bits would result so that adequate reception
quality may be obtained in relatively poor reception

5   conditions.

In the seventh exemplary embodiment of the invention, shown in
Fig. 8, the length of the time interval during which the
receiving unit 6 of the mobile station 5 switches to reception

10 of synchronization data packets and/or measurement of signal
levels from adjacent base stations, is chosen such that the
receiving unit 6 of the mobile station 5 can receive a first
portion of a synchronization data packet in a first time
interval, and can receive a second portion of a

15 synchronization data packet in a second time interval.

In Fig. 8, the first time interval is represented by the
dashed small boxes 0,1...7 in the first line, while the second
time interval is likewise identified in the second line by

20 dashed small boxes 0,1...7. If the same data are always coded
in the synchronization data packet, it is possible simply to
receive the burst in two parts, bit numbers 3 to 105 (the
first half) being received first, and bit numbers 42 to 144
(the second half) being received later. The training sequence

25 (bit numbers 42 to 105) must be received twice because they
are required for assessing the channel distortion, which is

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then used for equalization of the wanted data. However, a

shorter section for the training sequence could also be

sufficient, as a result of which the necessary time interval

is further shortened. The training sequence of the

5   synchronization data packet is of such a length that it can

easily be found by correlation. A shorter training sequence

will be sufficient to assess the channel impulse response.

However, it would then be necessary to solve an equation

system rather than using the correlation method. Depending on

10   the reception conditions, the necessary portion of the

training sequence may also be shorter or longer.

However, the data in the synchronization data packet are not

constant but also contain the respective time frame number.

15   The time frame number is contained in coded form in the

respective training sequence. If the time frame number is

decoded, then only a single bit changes in the majority of

cases. The change by one bit can be represented by an

exclusive-OR operation. The nature of the coding of the

20   synchronization data packet (convolution code and fire code)

makes it relatively easy to carry out such an exclusive-OR

operation on the coded bits as well, and, thus, to use the

first half of the synchronization data packet received at one

time to calculate at another time the half of the

25   synchronization data packet that was not received. In the

case of convolution codes, the relevant coded bits just need

to be inverted, and with fire codes, the corresponding

polynomial division governs the bits to be changed before use

of the convolution code, and the bits to be inverted.

5 Thus, decoding can be carried out conventionally. The

decoding is, of course, successful only in 50% of cases, in

which only one bit is actually different. If the decoding

fails, then the cases in which the corresponding bits of the

coded time frame number in the training sequence change may

10 then also be considered successively. As an alternative, a

further decoding attempt may also be made at a later time.

The later time would be 26 + (4 or 5) x 51 = 230 or 281 time

frames later.

15 In the seventh exemplary embodiment, the time interval in

which the mobile station is switched to reception of

synchronization data packets from adjacent base stations does

not need to be nine timeslots long, but eight timeslots plus

the length of the portion of the training sequence required

20 for channel assessment + the length of one data half of the

synchronization data packet. The time for the second data

half of the synchronization data packet, possibly plus the

portion of the training sequence that is not required for

decoding, is thus saved. Wanted data packets may be received

25 in the time that is saved.

The seventh exemplary embodiment is advantageous, in
particular, in combination with one of the preceding exemplary
embodiments if, the receiving unit 6 of the mobile station 5
requires too much time to change over to the appropriate

5   channel for reception of synchronization data packets from
adjacent base stations.

As already mentioned above, multiple timeslot mobile stations
have been defined in order to increase the data rate over the

10 data rate of standard mobile stations, and they receive and
transmit data in a plurality of timeslots. If such a multiple
timeslot mobile station has to transmit and receive
simultaneously, because transmitting and receiving timeslots
are superimposed, then the complexity of the mobile station

15 configuration is considerably increased. The complexity is
increased because the transmitting unit and the receiving unit
cannot share any common components (such as a synthesizer,
power supply, parts of A/D and D/A converters, and timing
signals), the receiving unit must be shielded from the

20 transmitter sufficiently well so that the transmitter does not
interfere with it (requiring more complex shielding measures),
and a duplexer must be used toward the antenna. However, with
the prior art, the advantageous situation is possible only
when at most two timeslots are used for transmission and at

25 most five timeslots are used for reception. In the class
breakdown for GSM mobile stations, Type 1 mobile stations,

that is to say mobile stations that do not transmit and receive at the same time, are, thus, defined for a limited combination of transmission/ reception timeslots.

5 Fig. 9 shows such an overlap of transmission and reception timeslots in a mobile station. The first line in Fig. 9 shows the received timeslots 0, 1, 2, 3 through solid lines. The transmitted timeslots 1, 2, 3 in the second line are likewise shown through solid lines. The overlap area between the

10 transmitted timeslot 1 and the received timeslot 3 is not equal to zero for a timing advance. The example illustrated in Fig. 9 relates to a 4E3S mobile station, in which a maximum of four timeslots are received successively and a maximum of three timeslots are transmitted successively. Apart from the

15 overlap area, no timeslots are transmitted while timeslots are being received, and vice versa.

Therefore, the prior art mobile stations have the disadvantage that the overlap between the transmission and reception

20 timeslots explained in Fig. 9 requires increased complexity for elements in the mobile stations. Furthermore, half-duplex mobile stations are introduced. In these mobile stations, the mobile station only receives, but does not transmit, for a predetermined time, and also does not carry out any adjacent

25 channel measurements. The mobile station then has a reception pause in which it carries out adjacent channel measurements,

and after which it switches to transmission. The condition is of particular interest for asymmetric operation, for example, when there is a high data rate in the downlink, but a low data rate in the uplink (Internet surfing). A disadvantage with

5   the method is the fact that, due to the pauses, the transmission capacity of the base station cannot be fully utilized.

In the eighth and ninth exemplary embodiments, the problem is

10 countered in that a first mobile station does not transmit data packets while being switched to reception of data packets at the same time, while a second mobile station is switched to reception of data packets in timeslots in which the first mobile station is transmitting data packets and transmitting

15 data packets in timeslots in which the first mobile station is switched to reception of data packets.

The first line of Fig. 10 uses solid lines to show the timeslots 0, 1, 2, 3 in which data packets are transmitted by

20 a first mobile station and, in the second line, shows those timeslots 2, 3, 4 in which data packets are received by the first mobile station. In the third line, those timeslots 4, 5, 6, 7 are each shown by solid lines in which data packets are received by the second mobile station, while, in the

25 fourth line, those timeslots 6, 7, 0 are shown in which data packets are transmitted by the second mobile station. Those

transmission and reception timeslots that would be used for simultaneous transmission and reception in a mobile station are thus shifted in time to other timeslots, with simultaneous transmission and reception being impossible. Thus, in fact,

5   the mobile station occupies more timeslots overall, and, thus, uses more network resources than necessary. However, the use is compensated for by the fact that the second mobile station transmits and receives in an interleaved manner such that all eight timeslots per time frame are nevertheless used. The

10 second mobile station may either likewise be a mobile station that transmits according to the invention, or a conventional multiple timeslot mobile station that, however, transmits in fewer timeslots than the timeslots in which it receives.

15 The eighth exemplary embodiment, which is shown in Fig. 10, illustrates how two 4E3S mobile stations transmit and receive without any overlap. The exemplary embodiment also applies when the second mobile station receives in four timeslots and transmits in two timeslots, in which case the transmission

20 timeslot 0 is not occupied by the second mobile station (fourth line in Fig. 10).

The ninth exemplary embodiment, shown in Fig. 11, illustrates the necessary combination with one of the preceding exemplary

25 embodiments 2 to 7. One of the exemplary embodiments 2 to 7 must, of course, be used at the same time in order to allow

synchronization with adjacent base stations to be carried out

because the time to search for synchronization data packets

from adjacent base stations in the predetermined time frame

takes up less than nine timeslots. As can be seen in Fig. 11,

5   the base station 1 transmits the data packet of the timeslot

immediately after a predetermined time frame immediately

before the start of the predetermined time frame, as is shown

by the timeslot 0R. The first mobile station, however,

carries out a measurement of the signal levels of adjacent

10   base stations in the first three timeslots of the

predetermined time frame while, in the next five timeslots

4,5, ...0, it searches for synchronization data packets from

adjacent base stations. The lower half of Fig. 11 shows the

adjacent channel search for the first mobile station in the

15   next predetermined time frame, in which the mobile station

searches for synchronization data packets from adjacent base

stations in the first five timeslots 0,1..., 4, and measures

the signal levels from adjacent base stations in the last

three timeslots. The first mobile station, explained by way

20   of example in Fig. 11, is likewise a 4E3S mobile station.